ROLE OF FILTER-FEEDING CRUSTACEAN ZOOPLANKTON IN DUTCH LAKES OF VARYING DEPTH AND TROPHY

Most freshwater lakes in The Netherlands are man-made, small (area 50–200 ha), shallow (mean depth 1–2 m) and highly eutrophic. The major symptoms of the eutrophication are: 1) high standing crop of seston (phytoplankton and detritus) (10–20 mg DW.L^{-1}) comprised mainly of filamentous blue-green algae; 2) high chlorophyll a levels (100–300μgL^{-1}); and 3) poor under-water light climate (Secchi-disc transparency, 30–50 cm). The mesotrophic lakes, which are relatively less common are, on the other hand, deep and exhibit summer stratification; they have much lower algal and detrital concentrations, and the light penetrates to deeper layers. Recently, attempts have been made to restore some of the eutrophic lakes (Loosdrecht Lakes) by reducing the external phosphorus loading (Van Liere *et al.*, 1990). In many other smaller lakes biomanipulation has been attempted as a lake rehabilitation measure (Gulati, 1990a, b). These restoration measures offered a good opportunity to follow the course of changes in the structure and grazing of crustacean zooplankton.

Results and Discussion

There are major differences between the two trophic categories of these lakes in the composition, size structure and grazing activities of the crustacean zooplankton. In the shallow, eutrophic category larger-bodied crustacean filter-feeders, *viz. Daphnia* species (>1.5 mm), are generally scarce, or even absent; instead, the smaller-bodied, filter-feeding crustaceans, (*Bosmina longirostris, B. coregoni, D. cucullata* and *Chydorus sphaericus*) are abundant, besides 3–5 species of cyclopoid copepods. It is puzzling, however, that one *Daphnia* species, *D. hyalina*, which invariably coexists with *D. cucullata* in both the eutrophic lakes and mesotrophic lakes, is absent in several other eutrophic lakes (Gulati, 1990b). The calanoid copepod *Eudiaptomus gracilis* is an important indicator of trophic status, being sparse or absent in eutrophic lakes. The limnetic zooplankton of the eutrophic lakes is dominated by rotifers which, with their mean densities of *c.* 4000 ind.L^{-1} outnumber the crustaceans by 9 to 1. The size structure of crustacean community also differs: in the mesotrophic lakes the mean crustacean size is larger (3–11 μg C.ind^{-1}) than in the eutrophic lakes (0.65 μg C.ind^{-1}). Biomass relationships between the crustaceans and their sestonic food (< 150 μm) indicates a Monod type of relationship with an initial part of the curve in which the zooplankton responds linearly to the seston increase to about 2 mg C.L^{-1}, observed in the mesotrophic and biomanipulated lakes. At seston levels of 3–4 mg C.L^{-1}, the zooplankton mass (0.4 mg C.L^{-1}) reaches a saturation level. At higher seston levels (4–10 mg C.L^{-1}), the food is dominated by blue-green algae, so that zooplankton mass tends to decrease rather than increase, possibly due to the inhibitory effects of the food. The structural differences between the crustaceans in these lakes are attributable to differences in the intensity of the size-selective predation or on the larger-bodied crustaceans by planktivorous fish. These fishes, especially bream (*Abramis brama*), and other young-of-the-year planktivorous fish, are far more abundant in the eutrophic lakes than in the mesotrophic and biomanipulated lakes. Experimental biomanipulation, i.e. artificial reduction in planktivorous fish, or alternatively increase in piscivorous fish, in some of the smaller eutrophic waters has led to the appearance of and dramatic increases in large-bodied *Daphnia* species. These changes generally go hand in hand with corresponding differences in the grazing pressure of the filter-feeders. The specific filtering rates (filtering rates per unit body weight, l.mg^{-1} zoop. C) in the deep mesotrophic lakes (1–3.5 l.mg zoop. C.L^{-1}) are 2 to 5 times higher than in the eutrophic lakes. The crustacean zooplankton is thus an important causal factor in the phytoplankton mortality in deeper lakes. In the eutrophic lakes, on the contrary, the seston standing crop is high, dominated by filamentous blue-greens which are poorly edible. The smaller-sized crustacean zooplankton which dominate in the eutrophic lakes is much less effective in grazing down the food than the larger-bodied species in the mesotrophic lakes. To eliminate the daily phytoplankton primary production in the eutrophic lakes (e.g. Lake Breukeleveen in the Loosdrecht area) about 525 ind.L^{-1}.d^{-1} of the crustacean grazers are required, compared with only about one-tenth of this number needed to remove the daily production in the mesotrophic and biomanipulated lakes.

Literature Cited

Gulati, R.D. 1990a. Zooplankton structure in the Loosdrecht lakes in relation to trophic status and recent restoration measures. Hydrobiologia **191**: 173–188.

1990b. Structure and grazing responses of zooplankton community to biomanipulation of some Dutch water bodies. Hydrobiologia **191**: 200–201.

Van Liere, L., Gulati, R.D. Wortelboer, F.G. and Lammens, E.H.R.R. 1990. Phosphorus dynamics following restoration measures in the Loosdrecht lakes. Hydrobiologia 191: 87–95.

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